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Growth Performance And Economic Impact Of Broilerchicken Fed Concentrates Supplemented With Processed Cocoa Pod Waste

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A B S T R A C T

The study was conducted to examine the performance growth and economic impacts of broiler chicken fed concentrates supplemented with processed cocoa pod waste. The experiment was conducted at the Teaching and Research Farm, University of Uyo, Uyo, Akwa Ibom State. Cocoa pod waste or husk was collected and processed by ash treatment to form a processed cocoa pod husk meal (PCHM). Three experimental diets were formulated at both the starter and finisher phases, in which PCHM was included at 0, 5 and 10% and designated as diets 1, 2 and 3, respectively. One hundred and eighty 1-day-old Arbor Acres broiler chicks were randomly distributed to three dietary treatments (10 birds/replicate; 60 birds/treatment) in a completely randomized design. The growth performance, carcass, relative internal organ weights and haemato biochemical indices were determined. Histological examination of the liver and heart samples was also determined. Results: The PCHM inclusion did affect (P < 0.05) the performance characteristics of the broiler chicks and also for the feed intake that significantly (P < 0.05) increased in birds fed 8% of PCHM-inclusive diet at the starter phase. The carcass traits, relative internal organ weights, haematological indices and serum biochemical indices of the broiler chickens were similar (P > 0.05) across the dietary treatments. The serum glutathione peroxidase and catalase concentration were higher (P < 0.05) in birds fed PCHM-inclusive diets compared to those fed the control diet. Implications and recommendations were made from the findings of the study.

Keywords: *Broilers, cocoa pod waste, Growth performance, Economic impacts.*

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INTRODUCTION:

Feeds and feeding constitutes a larger proportion of the expenditure in the poultry industry especially when ingredients like grains are used. According to Nworgu et al. [1] feeding cost covers between 60 to 70% of the total production cost of monogastric animals. Therefore, replacement of one or more of the major conventional feed ingredients with cheap and available non-conventional feed ingredients will have reducing effects on animal feed production cost [2]. The use of agro-wastes such as cassava peels and cocoa bean shell in monogastric animal production was reported [3]; [4], [5]; [6], [7] to have positive effects on monogastric animals especially poultry. Feeding of poultry with phytochemicals (products derived from plant, e.g. dried plant material, essential oil, pure isolated compound, or extract, which contain secondary plant metabolites) has been reported as a reliable means of combating the negative effect of oxidative stress in heat-stressed poultry [8].

Cocoa pod husk is a typical under-utilized agro-waste from the commercial cocoa farm, which could provide nutritional benefits to monogastric animal production [2]. Cocoa pod husk forms about 70% (w/w) of the whole mature cocoa fruit; has low crude protein (9.14%), high crude fibre (35.78%) [9] and anti-nutritional factors such as threobromine (2.64%); and has tannin (0.91%), caffeine (1.14%) and high fibre [2]. However, it was also reported that the optimal utilization of agro-waste in monogastric animal production is hampered by the anti-

nutritional factors which cause the inactivation of some nutrients, diminution of metabolic utilization of food or the process of food digestion [10]. Therefore, various treatments such as fermentation [11]; [12], ash treatment [13], enzyme supplementation [7],[14], soaking and sun-drying Adebowale[1] as cited in [15] among others have been used to improve the nutritive value of agro-waste. In particular, combination of ash treatment with fermentation was also reported to improve the nutritive values of cocoa pod husk meal and its suitability in monogastric animal production [2]. Dietary inclusion of processed cocoa pod husk meal up to 150 g/kg was reported to support normal growth performance, carcass traits and relative internal organ weights in the rabbits [15].

Variation could occur in performance response of different species of animals to unconventional feed ingredients, and presently, relatively few works had been reported on the effect of dietary processed cocoa pod husk in broiler chickens nutrition. Therefore, this study is aimed in determining the effects of fed concentrates supplemented with processed cocoa pod waste on broiler chickens.

METHODS AND MATERIALS:

Location of study

The experiment was carriedout at the Product Development Unit of the Research Department, University of Uyo, Uyo, Akwa Ibom State. Akwa Ibom state is in Nigeria. It is located in the coastal southern part of the country, lying between latitudes $4^{0}32^{1}$N and $5^{0}33^{1}$N, and longitudes $7^{0}25^{1}$E and $8^{0}25^{1}$E. The state is located in the south-South geographical zone, and is bordered on the east by Cross River State and Rivers State,, on the west by Abia state, and on the south by Atlantic Ocean and the south-most tip of Cross Rivers State.

Collection and preparation of test ingredients

Cocoa pod waste were collected from the cocoa farm in Uyo cash crop farm. Later the husk were chopped into slices at the Product Development Unit Of the Research Department. There were sundried for about 24hours to reduce the moisture content to about 80%. The pre-dried slices were then passed through a combination mincer and pelleting machine to produce pallets. The pallets were again dried for about 4days to further reduce the moisture content to about 10% and stored until used.

Experimental diets, Birds, Housing and experimental Design

Three experimental diets were formulated to meet the minimum requirements of the birds at both the starter and finisher phase, in which PCHM was included at 0, 5 and 10% and designated as diets 1, 2 and 3 respectively. One hundred and eighty 1-day-old Arbor Acres broiler chicks were randomly distributed to three dietary treatments (10 birds/replicate; 60 birds/treatment) in a completely randomized design (CRD). The birds in each replicate were housed in their respective wood shavings littered 200 × 100 cm pen. The experimental house temperature was maintained within 31
°C ± 2 for the first 7 days and reduces by 2 °C after each consecutive 7 days until the house temperature was 26 °C ± 2. Illumination was provided for 23 h/day. The birds were fed water and mash ad libitum throughout the experimental period.

Statistical analysis:

The data were subjected to one-way analysis of variance using SPSS version 20. The differences among means were determined by Duncan multiple range test of the same package.

RESULT AND DISCUSSION:

Table 1 shows the proximate composition and phytochemicals in the PCHM.

Table 1: Chemical composition of processed cocoa pod husk

Ingredients	Quantity(g/kg)
Ash (%)	150.30
Crude fibre (%)	147.62
Crude protein (%)	137.13
Ether EXtract (%)	64.38
Nitrogen free Extract (%)	382.12

Caffeine	0.03
Tannine	0.11
Threbomine	0.35
ME	2421.98 Kcal/kg

Metabolizable = (37 × %CP) + (81.8 × %FAT) + (35.5 × %NFE) Pauzenga[17], ME metabolizable

Table 2: Composition of Experimental Diet

Ingredients (%)	Diet 1, 0% PCHM	**Diet 2, 5% PCHM**	Diet 3, 10% PCHM
Maize	40.00	40.00	40.00
SBM	10.23	13.75	27.50
Fish meal	25.60	26.78	27.92
Bone Meal	1.50	1.50	1.50
Oyster shell	2.00	2.00	2.00
Palm Oil	1.00	2.00	2.20
Premix *	0.25	0.25	0.25
Methionine	0.35	0.35	0.35
Lysine	0.20	0.20	0.20

Salt	0.26	0.26	0.26
PCHM	0	5	10
Chemical Analysis (g/kg DM)			
Crude protein	21.90	21.78	**21.80**
Crude fibre	3.68	4.14	**4.58**
Calculated Analysis (g/kg DM)			
ME (Keal/Kg)	**2978.33**	**2957.42**	**2935.04**
Ca	1.77	1.77	1.77
Available P	0.78	0.77	0.76
Methionine	0.80	0.80	0.80
Lysine	1.20	1.14	1.99

PCHM- Processes cocoa husk meal

Table 3: Growth Performance characteristics of Chicken broilers fed experimental diet

Levels of inclusion (%)				
	0	**5**	**10**	
Parameters	**1**	**2**	**3**	**SE (±M)**
Ave.initialweight(kg)	9.05	8.98	9.00	
Ave.finalweight(kg)	28.84[b]	30.67[a]	35.00[c]	0.46
Ave.totalweight gain(kg)	12.52[b]	23.79[a]	26.00[d]	0.44
Ave. daily weight gain(kg)	2.07[b]	2.40[a]	1.86[c]	0.64
Feedintake(kg)	35.00	35.00	35.00	0.01
Feedconversion ratio	2.41[c]	2.06[d]	2.69[b]	0.68
Protein efficiency ratio	2.18[b]	2.52[a]	1.95[c]	0.08
Mortality (%)	-	-	-	-

a , b, c, d, e means along the same row with different superscripts are significantly (p< 0.05) different from each at her, Ave: Average, SEM: Standard error of mean.

Initial live weight of chicken broilers ranged from 8.98kg to 9.05kg, average final weight gain of the chicken broilers obtained are shown in table 3 revealed that, experimental animals were significantly (P<0.05) affected by the experimental diets. Increasing levels of cocoa pod husk meal in the concentrate feed supplement resulted in steady increase in body weight of 28.84g, 30.67g, 35.50g and 38.50g for pigs on diets 1, 2, and 3 respectively. Weight gains of chicken broilers fed concentrate feed deprived of forage (Diet 5) dropped significantly (P<0.05) to 20.48g. Therefore, 10% cocoa pod waste meal supplementation supported the highest daily live weight gain in the pigs respectively. Feed intake values were not significantly affected at finisher phase; results were the same across the groups. Feed conversion ratio differed significantly (P<0.05) in the experimental animals, while animals on 12% (2.06) diet gave the best compared to other diets with corresponding values of 0(2.41), 5(2.69) and 10(2.80) respectively.

Total weight gain determination was reported as the most frequent approach of assessing the overall nutritional status or health of broiler chickens [18]. The stability of the body weight gain and feed conversion ratio in the experimental birds across the various dietary treatments in this study suggests that PCHM demonstrates similar nutritional quality to the conventional ones and that it supports the normal growth performance in broiler chicken. It also suggests that PCHM could be a suitable replacement for some conventional livestock feed ingredients. This result is in line with the earlier reports of Akinfala et al. [19] and Afolayan et al. [20] that

conventional feed ingredients such as maize could be replaced in part by cassava and sweet potato meal, respectively, in broiler. Adeyeye et al. [15] also reported the support of processed cocoa pod husk meal for normal growth of growing rabbits at 15% inclusion level. The larger proportion of broiler chicken growing cycle is represented by the starter period [21]. The rise of feed intake in broiler chicken fed diet 3 being observed only at the starter phase may imply that there exist some variations in the factors affecting feed intake in broiler chickens at the starter and grower phases. Feed consumption was reported to differ with the feed quality/composition, chicks' growth rate and management conditions [22]. In addition, chicks regulate their feed intake to meet up with their energy requirement for growth [22]; [21]. This may explain in part the reason for the observed increase in feed intake across the diet as there exists a marginal decrease in the energy level of the feed with the increase in inclusion levels of PCHM across the diets in this study. However, the increased feed intake at this starter phase does not translate to increased growth performance. This may be due to the adverse effects of the phytochemicals in PCHM. For instance, tannin was reported of being capable of altering the growth rate and feed efficiency in animals [10].

Table 4: Percentage carcass and organ weights of the experimental pigs

Levels of inclusion (%)				
	0 (control)	**12**	**14**	
Parameters	**1**	**2**	**3**	**SE (±M)**
Slaughter weight (g/ bird)	2424.71[a]	2562.49[ab]	2837.48[b]	126.33
Dressed weight(g/ bird)	1871.32	1938.00	216301.	9745.
Dressing percentage (%)	74.87[a]	72.46[b]	71.37[c]	0.45
Internal Organs (%)				
Heart	0.30[a]	0.03[b]	0.39[a]	0.03
Lung	1.63	1.53	1.51	0.12
Liver	2.04[b]	2.92[b]	2.69[a]	0.10
Spleen	0.29[b]	0.84[b]	0.46[a]	0.10
Pancreas	0.21[b]	0.03[a]	0.32[ab]	0.20
Kidney	34.43	34.88	34.52[a]	0.20
Gizzard	2.04[b]	2.29[ab]	2.69[a]	0.23
Gall bladder	2.90[ab]	1.86[c]	2.00[cb]	0.37

a,b,c Means in the same row with different super script are significantly different

Nutrition has marked effect on yield of quality meat of animals, and their relative organ weights are very useful in the prediction of toxic effect of the test materials or the diets. In addition, the toxins in diet could be absorbed and accumulated in the various target tissues or organs and cause injury to the cells and alter their normal structure or function. The similarity in the carcass traits and relative internal organ weights of the experimental birds fed the varying inclusion levels of PCHM is of health benefits and indicates that the phytochemicals in PCHM is or fatal effects or that the dietary treatment in this study did not pose treats to the development of edible portion of the experimental birds and the normal gross anatomy of their internal organs.

The carcass and internal organ characteristics of chicken broilers with processed cocoa pod husk meals shown in table 5. Significant differences were found for percentage slaughter weight ($P<0.05$) and also for dressing percentage ($P>0.05$)showing that, the replacement of maize with processed cocoa pod husk meal in the diets of finisher chicken broilers did affect the resulting cold carcass weights of the chicken broilers when slaughtered. This was not in agreement with the findings of Johri [23], Alagbe[24], who also reported that, multi-enzyme addition did not affect carcass characteristics of broilers used in their study.

Table 6: Effects of processed cocoa pod waste meal on the erthrogram (i.e haemoglobin concentration/ serum biochemistry indices

Parameters	**A**	**B**	**C**	**SEM**
Haematological Indice				
Packed cell Volume (%)	33.08	31.63	31.88	266
Haemoglobinconcentration(g/l)	10.02	10.50	10.70	005
Red Blood Cell (x10)^{6}/UL	2.56	2.59	2.69	027
Serum biochemical indices				
Totalprotein (mg)	131.9[a]	125.18	126.8[ab]	023

/dl	8	b	5	
Cholestorol (mm) ol/l	38.88 a	38.88 b	37.53 b	0 0 9
Alanineamino transfera se (%)	29.03 b	31.02 a	29.33 b	2 1 0
Aspartateanimo transfer ase (U/l)	22.67 a	20.83 a	18.33 a	5 1 5
Serum antioxidant e nzyme				
Glutathione(Mmol/GSS G/min)	77.67 c	83.83 a b c	81.00 b c	0 5 9
Catalase(Ku/m) l	22.33 a	16.17 a b c	19.00 a b	0.031

a,b,c Means in the same row with different super script are significantly different

Erythrogram is one of the indicators for assessing the nutritional and health status of animals, and there exists a marked influence of nutrition on haematology traits [25]. The stability of packed cell volume, haemoglobin concentration and red blood cells of the birds fed diets containing varying levels of PCHM also shows that the dietary treatment used in this study did not have negative effects on the normal blood-forming processes in the experimental birds. This result agrees with Adeyeye et al. [2], who reported similar haematological indices values among experimental rabbits fed processed cocoa pod husk meal-inclusive diets. The assessment of biochemical parameters is also another important method of assessment of health in animals [26]. The non-difference in the serum biochemical indices values in broiler chicken fed the experiment diets also indicates that dietary PCHM inclusion up to 8% support normal health in the broiler chickens. This may be the product of activities of the phytochemicals in the PCHM. For instance, caffeine intake

was associated with a lower risk of elevated alanine aminotranaferase [17]. The use of phytochemical in ameliorating the negative effects of heat-induced oxidative stress in birds has been reported [25].

Table 6 shows the effect of PCHM on haemato-biochemical indices and serum antioxidant enzymes. The packed cell volume, haemoglobin concentration and red blood cells of the broiler chickens were stable ($P > 0.05$) across the dietary treatment. In the same vein, the serum biochemical indices concentration in the experimental birds was not affected ($P > 0.05$) by the dietary treatment. The serum GPx and CAT concentration were higher ($P < 0.05$) in birds broilers fed PCHM-inclusive diets compared to those fed the control diet.

CONCLUSION:

This study was conducted to determine the growth performance and economic impact of broiler chicken fed concentrates supplemented with processed cocoa pod waste meal. A total of 180 1-day-old Arbor Acres broiler chicks were randomly distributed to three dietary treatments (10 birds/replicate; 60 birds/treatment) in a completely randomized design (CRD) and used for the study. Three experimental diets were formulated to meet the minimum requirements of the birds at both the starter and finisher phase, in which PCHM was included at 0, 5 and 10% and designated as diets 1, 2 and 3 respectively. The experimental house temperature was maintained within 31 °C ± 2 for the first 7 days and reduces by 2 °C after each consecutive 7 days until the house temperature was 26 °C ± 2. Illumination was provided for 23 h/day. The birds were fed water and mash ad libitum throughout the experimental period the data were subjected to one-way analysis of variance using SPSS version 20 while the differences among means were determined by Duncan multiple range test of the same package. The following were the concluded:

Various levels of inclusion of processed cocoa pod waste(husk) meal was significant with the growth performance, economic evaluation, and growth performance of pigs ($P = 0.05$). Dietary treatment had effect on the feed conversion ratio and feed cost per unit weight gain. Birds fed the control diet (0 PCHM) were lowest in dressing percentage whereas counterparts on 10% maize replacement with processed cocoa pod husk meal (PCHM) where highest in abdominal fat compared to pigs on other dietary treatments. This shows that feeding PCHM aid in internal organs increments and therefore results in significantly increment in carcass fat. Results from haematology and serum biochemical analysis shows that PCHM had no untoward effect on physiology and metabolism to the pigs.

The findings of this study therefore implies that cocoa pod waste meal supplemented can be a great meal in for all monogastric animals as it will increase the body weight, aid growth and promote large meat production. Also, it will reduce the cost expenses on the farmers as the cost of making or getting this feed is relatively easy and low. It is therefore recommended that processes cocoa pod waste meal;

1. Should be encouraged in the feeding of broiler chickens to reduce over dependence of maize feeds by our farmers which have led to high cost of raising monogastrics.
2. Public extension/ advisory staff should be mobilized to convey these results to practicing farmers.
3. The inclusion of PCHM as shown in the result above promote the growth performance and feed conversion efficiency of broiler chicken and as such as been recommended for use by farmers.

REFERENCES

1. Nworgu, F. C., Adebowale, E. A., Oredein, O. A. & Oni, A. (1999) Prospect and economics of broiler production using two plant protein sources. *Tropical Journal of Animal Science 2,*159–166
2. Adeyeye, S. A., Agbede ,J. O., Aletor, V. A., & Oloruntola, O. D. (2017) Processed cocoa (Theobroma cacao) pod husks in rabbits diet: effect on haematological and serum biochemical indices. *Asian Journal of Advanced Agricultural Research 2*(4),1–9
3. Egbunik, G. N., Agiang, E. A., Owosibo, A., & Fatufe, A. A. (2009) Effect of protein on performance and haematology of broiler fed cassava peel-based diets. *Architectural Zootecnology, 58*(224),655–662
4. Ogunsipe, M. H., Ibidapo, I., Oloruntola, O. D. & Agbede, J. O. (2017a) Growth performance of pigs on dietary cocoa bean shell meal. Livestock Res Rural Dev 29(1) .

5. Ogunsipe, M. H., Balogun, K. B., Oladepo, A. D., Ayoola, M. A. & Arikewuyo, M. T. (2017b) Nutritive value of cocoa bean shell meal and its effect on growth and haematology of weaning rabbits. *Nigerian Journal of Agricultural Food Environment 13*(1),23–28
6. Oloruntola, O. D., Agbede, J. O., Onibi, G. E., Igbasen, F. A., Ayodele, S. O., Arogunjo, S. O. & Ogunjo, S. T. (2018a) Rabbits fed fermented cassava starch residue I: effect on performance and health status. *Architectural Zootecnology67*(260),578–586
7. Oloruntola OD, Agbede JO, Onibi GE, Igbasan FA, Ogunsipe MH, Ayodele SO (2018b) Rabbits fed fermented cassava starch residue II: enzyme supplementation influence on performance and health status. *Architectural Zootecnology67*(260),588–595

8. Akbarian, A., Michiels, J., Degroote, J., Majdeddin, M., Golian, A. & Dmegt, S. D. (2016) Association between heat stress and oxidative stress in poultry: mitochondrial dysfunction and dietary interventions with phytochemicals. *Journal of Animal Science Biotechnology 7,*37.
9. Eghosa, O. U, Rasheed, A. H., Martha, O. & Luqman, A. A. (2010) Utilization of cocoa pod husk (CPH) as substitute for maize in layers mash and perception of poultry farmers in Nigeria. *International Journal of Science Nature 1*(2),271–275
10. Gemede, H. F., & Ratta, N. (2014) Antinutritional factors in plant foods: potential health benefits and adverse effects. *International Journal of NutritionalFood Science, 3*(4),284–289 http://www.sciencepublishinggroup.com/j/ijnfs https://doi.org/10.1186/s40104-016-0097-5
11. Alemawor, F., Dzogbefia, V. P., Oddoye, E. K. & Oldham, J. H. (2009) Effect of Pleurotus ostreatus fermentation on cocoa pod husk composition: influence offermentation period and Mn2+ supplementation on the fermentationprocess. *African Journal of Biotechnology 8(9),1950–1958*
12. Oloruntola, O. D., Agbede, J. O., Onibi, G. E., Igbasan, F. A. (2015) Composition of cassava (Manihot spp.) peels fermented with bovine rumen liquor and different nitrogen sources. *Journal of Global Agricultural Ecology 2*(1),26– 35
13. Adamafio, N. A., Cooper Aggrinage. E., Onaye, E. O., Laary, J. K., & Onaye, J. (2004) Effectiveness of corn stalk ash in reducing tannin level and improving in vitro enzymatic degradation of polysaccharides in crop residues. *Ghana Journal of Sci ence, 44,*87–92
14. Oloruntola, O.D., Ayodele, S. O. & Oloruntola, D. A. (2018c) Effect of pawpaw (Carica papaya) leaf meal and dietary enzymes on broiler performance, digestibility,carcass and blood composition. *Review Elevated Medical Vetenary Pays Tropics 71*(3). https://doi.org/10.19182/remvt.31640
15. Adeyeye, S. A., Agbede, J. O., Aletor, V. A. & Oloruntola, O. D. (2018) Performance and carcass characteristics of growing rabbits fed diets containing graded levels of processed cocoa (Theobroma cacao) pod husk meal supplemented with multi-enzyme. *Journal of Applied Life Science International, 17*(2),1–11
16. Pauzenga U (1985) Feeding Parent Stock. Zoo Technical International. pp 22–24.
17. Ruhl, C. E, & Everhart, J. E. (2005) Coffee and tea consumption are associated with a lower incidence of chronic liver disease in the United States. *Gastroenterology 129*,1928–1936
18. Parvin N, Mandal TK, Saxema V, Sarkar S, Saxena AK (2010) Effect of increasing protein percentage feed on the performance and carcass characteristics of broiler chicks. *Asian Journal of Poultry Science 4*(2),53–59
19. Akinfala, E. O., Aderibigbe, A. O., & Matanmi, O. (2002) Evaluation of the nutritive value of whole cassava plant as replacement for maize in the starter diets for broiler chickens. *Livestock Research for Rural Development 14*(6). http://www.lrrd.org/lrrd14/6/akin146.htm
20. Afolayan, S. B., Dafwang, I. I., Tegbe, T. B. & Sekoni, A. (2012) Response of broiler chickens fed maize-based diets substituted with graded levels of sweet potato meal. *Asian Journal of Poultry Science 6*(1),15–22
21. Gajana, C. S., Nkukwana, T. T., Chimonyo, M., & Muchenje, V. (2011) Effect of altering the starter and finisher dietary phases on growth performance of broilers. *African Journal of Biotechnolgy 10*(64),14203–14208 http://www.academicjournals.org/AJB
22. Ferket, P. R., & Gernat, A. G. (2006) Factors that affect feed intake of meat birds: a review. *International Journal of Poultry Science, 5*(10),905–911
23. Johri, M. O. (2004), Effect of pawpaw (Carica papaya) leaf meal and dietary enzymes on broiler performance, digestibility,carcass and blood composition. *Review Elevated Medical Vetenary Pays Tropics 71*(3).
24. Alagbe S. T.(2017) Effect of altering the starter and finisher dietary phases on growth performance of broilers. *African Journal of Biotechnolgy 10*(64),14203–14208
25. Oloruntola, O. D,, Agbede, J . O., Ayodele, S.O. & Oloruntola, D.A. (2018d) Neem, pawpaw, and bamboo leaf meal dietary supplementation in broiler chickens: effect on performance and health status. *Journal Food of Biochemistry, 12,* 723 https://doi.org/10.1111/jfbc.12723
26. Milner, J. M., Stien,. A, Justin Irvine, R., Albon, S. D., Langvatin, R.& Ropstad, E. (2003) Body condition in Svalbard reindeer and the use of blood parameters as indicator of condition and fitness. *Canada Journal of Zoology 81,*1566–1578